To: Department of Ecology

From: Bert Rubash
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Date: November 27, 2006

Comments on the Supplemental Remedial Investigation & Feasibility Study, Volume 1: RI Report, Part 3, Environmental Setting, Section 3.1, Physical Conditions, Subsection 3.1.2, Surface Water and Circulation Patterns, prepared by The RETEC Group, Inc.

These comments were submitted previously by e-mail, but no acknowledgment was received so they are being resubmitted on paper in case the e-mail version was lost or mistakenly identified as spam.

This subsection was chosen for review because it doesn't appear to have been as carefully crafted as the rest of the RI/FS, although it contains an elaboration of a key operational assumption that informs and justifies the larger project. A statement of that assumption might be: 'We know enough about the dynamics of the bay to reliably predict where to look for the remains of Georgia Pacific's toxic waste, where it would be safe to leave some of it, how safe leaving it there would be, and how to monitor the security of what's left.'

Sediment source.

To make such an assumption we would need good estimates of the physical quantities involved. Unfortunately, one of the first quantities given, the annual discharge for the Nooksack River is ambiguous and unreferenced (1). The figure, 650,000 cubic meters of sediment discharge, is 5274 times smaller than the USGS figure for the mean water discharge for the years 1967-2000 at Ferndale: 3839 cfs (= 109 cubic meters/second => 3,430,000,000 cubic meters/year) (2). Combining the two discharges we have 1,000,000/5274 = 190 cubic centimeters of sediment in an average meter of Nooksack water. That's a little less than a cup, surprising, but reasonable. Was sediment volume measured, derived, guessed? We shouldn't have to wonder about its source, meaning, and validity. Are we be expected to search through the references listed at the start of the subsection (3) to find which document and which page contains the estimate and describes how the estimate was made?

Water exchange.

Less reasonable than the sediment volume figure is the assertion on page 3-6 that "The residence time for water in Bellingham Bay is typically four to five days, but varies between one and eleven days."

Studies of lakes and estuaries employ three measures of renewal, residence time, age, and flushing time (4).

Residence time, is the time elapsed from a water parcel's entry at a specified starting point until its departure. Age is the time elapsed since a parcel entered a water body, and the age of a water body is the average age of all water parcels. Flushing time, a more general measure, is the ratio of total

volume (or mass) of water to its rate of renewal due to flow across boundaries. Flushing time is often also called residence time.

The context of RETEC's residence time assertion is a discussion of "oceanic" waters "entering" and of water "exchange", not a discussion of particular water masses or of masses from a particular source, so it seems safe to assume that flushing time or something close to it is what RETEC had in mind.

We can approximate RETEC's derivation of the residence time figure by assuming that the bay is thoroughly mixed on a time scale much smaller than the residence time, and by assuming that water flows through the bay, not in and out of the bay. (Assume a river, not an estuary.)

The surface area of the semi-enclosed region between Samish Island and the Nooksack delta is 250,000,000 square meters; the volume of water is 5,650,000,000 cubic meters, in round figures (5). Using a tidal range of 3 meters, a tidal cycle of 24 2/3 hours, and Nooksack discharge of 9,680,000 cubic meters per tidal cycle derived from the USGS discharge figure above, we would have 3 X 250,000,000/24 2/3 = 30,400,000 cubic meters per hour moving through. It would take 5,650,000,000/(24 X 40,540,000) = 7.7 days to exchange the water in the bay at that rate, hence the "typically four to five days but varies between one and eleven days" assertion in the RI/FS, although the shorter times require more radical assumptions. A 4 meter tidal range would yield 5.8 days.

This may be a good estimate of water volumes surging back and forth past the southern end of Lummi Island, but it is not a good estimate of water exchange in the bay, that is, of residual tidal flow. The thoroughly mixed and through-flowing water assumptions are fatally unrealistic: the bay has strong vertical density stratification, and the tides flow in and out; residual tidal flow (over a cycle) is much smaller than instantaneous flow for most of the bay, approaching instantaneous flow rates only near the open boundaries.

The areas and volumes used above are taken from the model configuration for the work described in a poster at the June 4-9 2006 American Society of Limnology and Oceanography conference in Victoria. That poster described detailed computing and mapping of the flushing time of Bellingham Bay. Normal overall flushing time for the bay was determined to be 485 hours (20 days) with much longer times, an order of magnitude longer for a region of bottom waters in the northern part of the bay (5).

Sediment accumulation.

Using information in subsection 3.1.2 to estimate the sediment available for deposition, illustrates how that subsection is related to the larger remediation project. In that subsection we read that "there is a net southward flow throughout Bellingham Bay at depth, largely resulting from the lateral and vertical spreading of the Nooksack River discharge." We have read in 3.1.2 that the bay is an active water body with a residence time of a few days. 650,000 cubic meters of sediment is carried into that net southward flow. In such conditions sediments would be carried far and wide beyond the edge of the delta into the bay, sediments that would provide the natural capping of toxin containing sediments discussed in the RI/FS. (We also made the contrasting assumption that Georgia Pacific's waste settled near where it was dumped.)

How much capping we can expect? If we make the conservative assumptions that the accumulation on the tide flats at the delta does not divert a significant part of the sediment load, and that all of the

sediment settles in the northern third of the bay, we can expect that 650,000 cubic meters of sediment will be spread over 250,000,000/3 square meters, which is 0.78 centimeters annual accumulation.

The empirical analysis in Section 6.2.1, Table 6-1 of the RI/FS indicates twice that rate of deposition in the inner harbor area, 1.6 centimeters per year. This discrepancy means that the estimate of the amount of sediment available is too low, or that Squalicum and Whatcom creeks supply significant sediment, or that sediment deposition is uneven and presently greater in the area of the inner harbor.

If sediment deposition is uneven, how confident can we be that circulation, and the related depositional and erosional patterns will not change with land use changes and with climate change? A 1961 University of Washington master's thesis on Bellingham Bay sediments states that the growth rate of the sediments over the last 70 years is 900,000 cubic yards (823,000 cubic meters) per year, and that the growth of the delta in that period "is nearly as great as the total previously existing delta"(6). That statement should warn us that present sedimentation rates in the bay are transitory.

The geography and dynamics of sediment transport in the bay are also transitory, far more transitory. The largest Nooksack channel through the tide flats meanders along the northeastern shore, and conveniently directs the heaviest sediment plume toward Boulevard Park. How rapidly will that change; how soon will it meander elsewhere; how quickly will one of the meandering western tide flat channels deepen and carry the heaviest load to the west side of the bay? In short, how securely can we trust that some of the depositional environment we are counting on will not become erosional?

RI/FS improvement.

If the role of the RI/FS is to provide a basis for public confidence that enough is known about how the bay works to plan for safe, comprehensive remediation of Georgia Pacific's toxic legacy, then it needs improvement. Below are three suggestions.

The RI/FS needs better overall consistency. Since sediment deposition is predicted and required, it needs a sediment budget, a geographic sediment budget that accounts for delta growth and for transport dynamics.

The RI/FS also needs a mercury budget in order for the public to gage how well mercury itself, and the other toxins in the inner bay sediments are encompassed by the RI/FS.

A final suggestion to improve Subsection 3.1.2 would be to edit all unsubstantiated assertions: everything submitted for public review should be substantiated by derivations or by field data with documentation of methods, or by references that lead to derivations or field data. Everything that is not substantiated should be clearly identified as public relations information not intended for review. Expecting the public to trust the undocumented assertions of consulting experts is contrary to democratic principles and not a proper function of public agencies.

(1) "The Nooksack River is also the primary source of sediments to the bay, with an annual discharge of 650,000 cubic meters." quoted from page 3-5 of the RI/FS.

(2) See http://wa.water.usgs.gov/realtime/adr/2000/data/12213100.2000.sw.pdf for USGS discharge data.

(3) "Collias et al. (1966), Shea et al. (1981), and Broad et al. (1984) have previously described the physical oceanography of Bellingham Bay. In addition, a recent study of inner Bellingham Bay currents was performed by Colyer (1998)." quoted from page 3-5 of the RI/FS.

(4) See Monsen, N.E., Cloern, J.E., Lucas, L.V., and Stephen G. Monismith, G., 2002. A comment on the use of flushing time, flushing time, and age as transport time scales. Limnol. and Oceanogr. 47: 1545-1553.

(5) Consistent and Accurate Calculation of Estuarine Flushing in Bellingham Bay Using an Ocean Circulation Numerical Model, Rubash, L, L, Kilanowski, E, M, http://www.sgmeet.com/aslo/victoria2006/.

(6) Richard W. Sternberg, 1962, Recent Sediments in Bellingham Bay, Washington, Master of science thesis, University of Washington, page 57.

To: Department of Ecology

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Date: November 27, 2006

Questions and comments regarding the Supplemental Remedial Investigation & Feasibility Study, Volume 1: Appendix E, Data Used in the Development of the Site-Specific Mercury Bioaccumulation Screening Level

Data Format

Why was the statistical characterization of laboratory measurements from the lab reports--error estimates and threshold levels--not included in the data presented for public review?

Why was the public given digital PDF pictures of data tables rather than standard PDF files containing characters and numbers? Was it assumed that the public would not want to do anything with the tables other than look at them?

Data Clusters

The average of the internal sample deviations for the clusters for the crab data in Table 1 used in the regression is 0.0336, whereas the overall deviation for those 12 clusters is 0.0309. Judging by these measures of the scatter of the data, independence within clusters is greater than independence between clusters: why was the data in Table 1 clustered before performing the regression reported in Table 2?

It is true that another measure of independence for the whole data set, the adjusted R-squared of the regression for the clustered data, 0.7314, is significantly more than the value for the 23 individual points, 0.4273, but other selective clusterings could be found that would produce even better correlation; a clustering choice must be justified by other means than merely that it produces a desired result. That justification should be included in the Remedial Investigation.

(Comparing adjusted R-squared for the clam data is instructive; adjusted R-squared is *less* after clustering.)

A regression performed on the 23 data points for crab taken as individual data points would result in a 13% lower concentration for the sediment standard. Wouldn't performing regression on unclustered data have been more in keeping with the assertion that the methods used are consistently conservative?

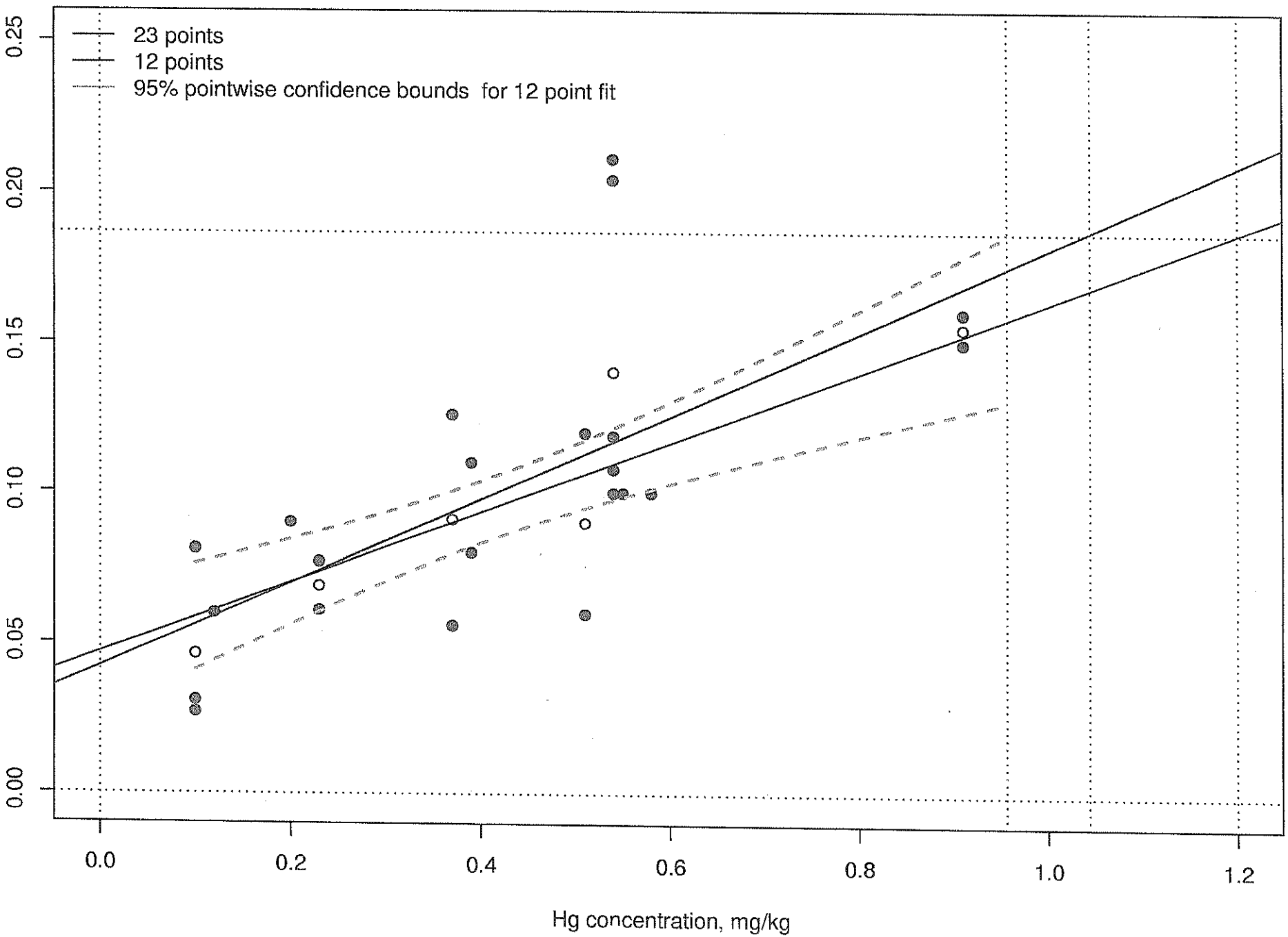
(A CDROM containing the spreadsheet used for the above calculations along with the R-script used for the regressions accompanies these comments.)

Regression Truth

Why wasn't the variability of the regression procedure included in the calculation of the sediment screening level? Fitting a line to a sample of sediment versus animal meat mercury concentrations is a means of estimating the relationship between them, not a means of discovering the relationship itself, which is a distribution, not an actual line. 95% point-wise confidence bounds for the 12-point regression would indicate a sediment standard of 0.96 mg/kg rather than 1.2 mg/kg. (See attached graph; confidence bounds are indicated by grey dashed lines.)

Proportionality of Benefits (in the Feasibility Study)

On page 220, Figure 7.1 of the Feasibility Study, "Medium Benefits" is 1/4 th of the distance between "Low Benefits" and "High Benefits". How does the source of this ranking, the information in Table 7-2 justify this proportionality?


Sediment –> Crab
23 points
12 points
95% pointwise confidence bounds for 12 point fit
0.25
0.20
0.15
0.10
0.05
0.00
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Hg concentration, mg/kg

10/30/06

Whatcom Waterway Site

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Comment Form

This is an invitation for comments on the draft Supplemental Remedial Investigation/Feasibility Study and draft Supplemental Environmental Impact Statement for the Whatcom Waterway site in Bellingham, Washington. If you wish to comment, please fold, affix postage, and mail this form to Ecology ~~by~~ December 9, 2006 (address on reverse).

Name and address optional

Name.... Anne Nesmith.....
Address.....
City..... Zip Code .....
E-mail Address.. sail.coast@earthlink.net.....

Computer projections predict a water level raise between 3 and 20 feet as a result of global warming. This depends on the severity of the land mass ice melt, but it could occur within the next 40-50 years. Does the EIS or RI/FS address this and if so, what assumptions are used. If not, why not?

From: Roni Beall [mailto:roni.beall@gmail.com]
Sent: Sunday, December 10, 2006 4:45 PM
To: McInerney, Lucy (ECY)
Subject: Bellingham Bay Clean-up

Capping rather than clean-up seems penny-wise and pound foolish to say the least. The economic health of our community and our children are greatly at risk if we simply cap and the near inevitable earthquake hits. Thanks for listening. I am strongly in favor of removing mercury and other contaminants from our waterways to the extent that is reasonably possible given the state of our current technology. Capping is folly!

--
Roni Beall

From: Thomas Gotchy [mailto:tellytom@msn.com]
Sent: Saturday, December 09, 2006 3:49 PM
To: McInerney, Lucy (ECY)
Subject: Bellingham Bay, GP site cleanup

Lucille McInerney,

We need to remove the mercury which contaminates the Bellingham GP site, not leave it buried in the sediment, where with time it will slowly leach out into Puget Sound. Maybe I'm getting this wrong, but I thought we were trying to clean up Puget Sound. I thought we were supposed to be doing something about levels of mercury found in our salmon and Orca populations. Now is the time to clean it up, not after more irreparable damage is done. Now is the time while it is still concerted in one small location, not after it has dispersed through the environment and becomes impossible to recover. Now is the time, not later. If it is the matter of money that is making us hesitate from doing the right thing, now is our open window of opportunity. Now is the least expensive time and we need to take advantage of this opportunity while we can. Tomorrow or the day after tomorrow will be to late.

Sincerely,
Thomas & Celestine Gotchy
2911 Ellis Street
Bellingham, Washington 98225
tellytom@msn.com

From: Alex Shapiro [mailto:akira@niftywerks.com]
Sent: Saturday, December 09, 2006 3:40 PM
To: McInerney, Lucy (ECY)
Subject:

hello, I am writing to demand as a whatcom county resident, that the dept of ecology mandate the full and entire cleanup of the bellingham bay and whatcom waterway. Please don't let the ports bad decision to adopt the liability allow the continued endangerment and exposure of all of us, including the wildlife, to the industrial pollution recklessly discarded by past generations.
thank you

Alex Shapiro
5930 Bell Creek rd/ box 86
Maple Falls, WA 98266
360-592-1387

BELLINGHAM/WHATCOM
CHAMBER OF COMMERCE & INDUSTRY

21 November 2006

Lucille T. McInerney, P.E.
Site Manager
Department of Ecology
3190 160th Avenue
Bellevue, WA 98008-5452
VIA E-MAIL: lpeb461@ecy.wa.gov

Ms. McInerney :

On behalf of the Board of Directors of the Chamber and our 800 members, I am writing to express our thoughts on the clean-up of the Whatcom Waterway Site in Bellingham, Washington.

After reviewing the materials from the Department of Ecology, **we are in support of Alternative #6 as the preferred mechanism for cleaning the site and preparing it for redevelopment.**

The 137 acres of land which make up the former Georgia Pacific site, and were transferred to the Port of Bellingham in January 2005, provide Bellingham and Whatcom County with an outstanding opportunity to return former industrial land which has been heavily contaminated to a more open, public use. The unique partnership between the Port and the City of Bellingham will allow the site to be fully redeveloped, providing housing, jobs, recreation, waterway access, and a full gamut of services to our community.

In cleaning the contaminants on the site, we believe that we must choose the option which provides for a nexus between public safety, redevelopment potential and cost. We believe Alternative #6 provides for this nexus by ensuring the full site can be used for redevelopment (including development of a public marina in the old GP Ponding Basin), while using approved methods to dredge, cap and provide for shoreline stabilization.

Alternative #6 has received a High overall MTCA ranking, meets all MTCA threshold criteria, and its restoration time frame is amongst the lowest of the eight alternatives being reviewed. Furthermore, MTCA ranks the overall benefits of Alternative #6 as High, finds the costs of the clean-up to be proportionate to the benefit, and that the alternative is permanent to the maximum extent practicable.

Many, many citizens of Bellingham and Whatcom County are excited about the potential of this important redevelopment project, and the membership of the Bellingham/Whatcom Chamber certainly certainly among them. Alternative #6 will provide our community with the best opportunity to clean this site, and return it to the use of the community. **Please support Alternative #6.**

Sincerely,

Kenneth Oplinger, President/CEO
Bellingham/Whatcom Chamber of Commerce & Industry

1201 Cornwall Avenue, Suite 100, Bellingham, WA 98225
Ph. 360/734-1330 Fax 360/734-1332 ken@bellingham.com

From: Leonard Duncan [mailto:duncancands@msn.com]
Sent: Monday, December 11, 2006 8:47 AM
To: McInerney, Lucy (ECY); Clint and Sara
Subject: Comments concerning Whatcom waterway EIS

Hello Ms. McInerney,
I have attached a word file containing comments re: the BSL portion of the Whatcom Waterway EIS.

Thank you for your consideration.
Clint Duncan

To: Lucille T. McInerney, P.E. Site Manager December 11, 2006
WDOE

From:
L. Clint Duncan 2601 Lummi View Drive
Bellingham, WA 98226
Email duncancands@msn.com
Phone 360.961.7614

The following comments concern the BSL (Biological Screening Level) sediment standards evaluation portion of the Whatcom Waterway RI/FS study document of October 2006.

Monomethyl mercury is bioaccumulated and biomagnified.[1] It is the species that remediation efforts ultimately address. We, as consumers are poisoned if we ingest contaminated food materials at a rate such that there is excessive monomethylmercury build up in our systems.

Remediation activities should follow a regulatory cleanup standard that is unambiguously derived and ultimately protective of marine and human health. The mercury BSL as described in Section 4.3 of the RI/FS was empirically derived using a small and suspect data set. It oversimplifies the complex link between sediment total mercury content and marine organism mercury content.

The basis of my criticism of the BSL has two parts a) theoretical and b) experimental.

a) We know that biologically mediated chemical reactions at the sediment - water interface result in conversion of mercury (II) species to the toxic monomethyl mercury[2] ion. The rate and extent of conversion of contamination mercury (II) species to monomethyl mercury at the sediment interface depends on a number of physical and chemical factors including

[1] US EPA (1997): Mercury study report to congress. US EPA, Dec. 1997.

[2] S.M. Ullrich, T.W. Tanton, and S.A. Abdrashitova, **Mercury in the Aquatic Environment; A Review of Factors Affecting Methylation**. Critical Reviews in Environmental Science and Technology, 31(3):241-293 (2001).

temperature, time of year, marine sediment organic content, sediment sulfide content[3], and the total mercury content of that sediment. The BSL formulation as described in section 4.3 "Protection of Human Health" included the variables sediment total mercury content and marine organism total mercury content. The variables organism type, mercury accumulation mode, sediment temperature, time of year, sediment organic content, and sediment sulfide content were not addressed. The extent of influence of other variables should be addressed. For example a recent study of monomethylmercury formation rates in Long Island Sound sediments by Hammerschmidt and Fitzgerald[3] showed the rate of formation of that toxin to depend strongly on sediment organic content and season as well as sediment total mercury content.

Once methylmercury is formed it then is bioaccumulated. Bioaccumulation success depends on a number of factors in addition to sediment mercury content. I will quote Lawrence and Mason[4] who performed studies to assess the bioaccumulation of mercury in estuarine amphipods. They stated "Experimental results coupled with results from a bioaccumulation model, suggest that accumulation of Hg (inorganic) and monomethyl mercury from sediment cannot be accurately predicted based solely on the total Hg, or even monomethyl mercury concentration in the sediment and sediment – based bioaccumulation factors." "All routes of exposure need to be considered in determining the accumulation of Hg (inorganic) and monomethyl mercury from sediment to benthic invertebrates."

Luoma and Rainbow[5] examined metal bioaccumulation for seven metals and 14 species of animals from 3 phyla and 11 marine, estuarine, and freshwater environments. They generated a model that included the predictors metal influx rates from water, influx rates from food, rate constants of loss, and receptor growth rate. Their model predictions were highly successful. Their work is significant in that tells us that the net extent of bioaccumulation in different species is expected.

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[3] C.R. Hammerschmidt and W.F. Fitzgerald, **Geochemical Controls on the Production and Distribution of Methylmercury in Near-Shore Marine Sediments,** Environ. Sci. Technol. 38,487-1495 (2004)
[4] A.L. Lawrence and R.P. Mason, **Factors controlling the bioaccumulation of mercury and methylmercury by the estuarine amphipod *Lepocherus Plumulosus*,** Environ. Poll, 111,217-231(2001)
[5] S.N. Luoma and P.S. Rainbow, **CRITICAL REVIEW: Why is Metal Bioaccumulation so Variable? Biodynamics as a Unifying Concept,** Environ. Sci. and Tech. 39,1921-1931(2005)

b) Section 4.3 of the RI/FS describes the formulation of the BSL. The Dungeness crab calculations section: Table 1 shows "Paired sediment and Tissue concentrations Data". 23 data pairs are shown. However on Table 2 "Derivation of Bioaccumulation-Based Sediment Mercury Cleanup Screening Levels" the bioaccumulation Regression Data shows the number of sample composites as 12.

Table 1 (Appendix E) shows for N=12; a least squares regression result:
y (crab Hg ppm) = .116 (sediment Hg ppm) + .047 $R^2_{adj} = .73$

When the full data set consisting of the 23 data pairs on table 1 (Appendix E) is used, the least squares regression result is: for N=23
y (crab Hg ppm) = .138 (sediment Hg ppm) + .042 $R^2_{adj} = .453$

1) It appears that sample data was averaged. The consequence of that averaging gives what I suspect is an improperly biased regression probability indication. If calculations based on the regression are used as a regulatory standard the --% confidence interval of particular forecast should be shown then discussed as well as the uncertainty of the whole approach!!

2) Were crab meat samples combined? If that is the case wasn't the study corrupted.

3) There is no data showing a sediment concentration of 1.2 ppm Hg paired with crab tissue data. Is it appropriate to forecast beyond the input data set when defining an enforcement standard??????

The concerned parties should design, and then implement a study aimed at clearly describing the relationship between the Whatcom Waterway mercury load and the steady state mercury concentration in the marine organisms that we consume. We need to understand the factors that control methylmercury formation, bioaccumulation, and then biomagnification if we are to appropriately treat the pollution in the waterway and surrounding areas.

Thank you for considering my comments.
L. Clint Duncan